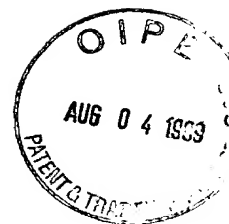


UNITED STATES PATENT SPECIFICATION



TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT, I, Kenji YONEDA, of Japanese Nationality, residing at Saganohaitsu 518, 26 Sagano Shibano-cho, Ukyo-ku, Kyoto-shi, Kyoto 616 JAPAN, has invented certain new and useful improvements in

~~METHOD OF MANUFACTURING LIGHTING UNIT~~

of which the following is a specification.

*stet*

*for inspecting a surface*

*a*

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## BACKGROUND OF THE INVENTION

This invention relates to a method of manufacturing a lighting unit which is preferably used when a product inspection is conducted <sup>using</sup> ~~by means of~~ reflected light

5 emitted by the lighting unit.

~~Methods of using lighting units to examine~~  
~~As a method for examining~~ a surface of a product ~~it~~  
~~have~~ <sup>In these methods, the surface of the</sup> has generally been known <sup>that a</sup> product to be examined is  
~~irradiated by a lighting unit, through its underside and~~  
~~then~~ the reflected light is visually inspected or <sup>photos of the</sup> ~~taken a~~  
<sup>surface are taken</sup> ~~photo~~ in close <sup>proximity</sup> ~~proximate~~ to the lighting unit. If ~~there~~

10 ~~exists~~ <sup>exists</sup> some unevenness in light intensity on the surface  
~~to be~~ <sup>being</sup> examined, ~~it may happen that~~ <sup>it may indicate that</sup> a micro flaw or a  
finishing defect on the surface of the product ~~to be~~ <sup>being</sup>  
examined ~~is failed to be~~ <sup>has not been</sup> detected. Therefore, ~~In~~ order to

15 examine a surface of a product it is ~~very popular~~ <sup>well known</sup> to use a  
lighting unit having ~~such an arrangement that~~ a plurality  
of illuminants, such as light-emitting diodes, ~~are~~ placed  
~~all over~~ <sup>along</sup> the underside of the lighting unit ~~and the whole~~ <sup>so that the entire</sup>  
underside thereof emits light areally ~~so as~~ <sup>in order</sup> to keep the  
20 light intensity on the surface to be examined even.

~~Especially in case that~~ <sup>This is especially true when</sup> a product to be examined is three-  
dimensional <sup>In this case,</sup> it is necessary to light up the product to be  
examined from ~~not only one direction but also~~ <sup>not only one direction,</sup> several  
directions, <sup>with light</sup> as if to cover the product. In such a case it

25 is usual to use a lighting unit having ~~such an arrangement~~  
~~that the~~ <sup>an</sup> underside of the lighting unit, namely the  
surface which emits light, <sup>that</sup> is a concave face of a hollow  
truncated cone shape and that <sup>has</sup> a plurality of illuminants

are arranged on the concave face.

However, if a lighting unit has the above-mentioned arrangement, in order to place a plurality of illuminants all over the underside of the lighting unit, complicated steps have to be taken, such as ~~the~~ <sup>ing</sup> process, the underside of the lighting unit to form a concave face of a hollow truncated cone or a hollow conic, ~~to~~ <sup>ing</sup> perforate a plurality of holes on the concave face, ~~to~~ <sup>ing</sup> embed illuminants in each of the holes respectively, and then ~~to~~ <sup>ing</sup> wire each of the illuminants by hand. <sup>These steps</sup> ~~This~~ makes it difficult <sup>and time consuming</sup> to assemble the lighting unit having the above-mentioned arrangement, ~~thereby taking longer time to assemble the lighting unit.~~ This also makes <sup>more</sup> it difficult to standardize a process of manufacturing a variety of lighting units having different angles <sup>for</sup> ~~of~~ emitting light because every step, such as processing the underside of the lighting unit or the angle of a hole, <sup>perforation</sup> ~~perforated~~ varies.

It is an object of the present invention to provide a method of manufacturing a lighting unit characterized by ~~that the lighting unit having such an arrangement that~~ a plurality of illuminants are <sup>set up</sup> on a concave face of a hollow truncated cone shape, <sup>that be</sup> can easily be manufactured.

#### SUMMARY OF THE INVENTION

In order to accomplish the above-mentioned object, the invention <sup>includes</sup> ~~has adopted the following~~ <sup>a</sup> method. ~~The method of manufacturing a lighting unit in accordance with the invention comprises~~ <sup>comprising</sup> the following steps of holding a flexible circular board having a concentric circular hole

and a cutout which has at least two sides in a planar state, embedding a plurality of illuminants in the board, and jointing one side of the cutout and the other side of the cutout or holding both sides <sup>of the cutout</sup> in close contact so as to  
5 place the illuminants in the side of the concave face.

With the above-mentioned method, a plurality of illuminants can easily be set up on a concave face of the hollow truncated cone-shaped board.

More specifically, the invention is a method of  
10 manufacturing a lighting unit ~~characterized by obtaining the lighting unit~~ in which a plurality of illuminants are arranged on a concave face of a board formed into <sup>the</sup> ~~a~~ shape of a hollow truncated cone ~~and~~ the illuminants are mounted on the underside of the lighting unit through the board by  
15 the steps of holding the flexible circular board having a concentric circular hole and a cutout <sup>with</sup> ~~which has~~ at least two sides in a planar state, embedding a plurality of illuminants such as light-emitting diodes or the like in the board, and then jointing one side of the cutout and  
20 the other side of the cutout of the board or holding both sides <sup>of the cutout</sup> in close contact.

In particular, in order to further simplify assembling operations, it is preferable to use a printed circuit board as the above-mentioned board so that the  
25 operations of wiring each illuminant~~s~~ and embedding each illuminant~~s~~ in a board can be done at <sup>one time</sup> ~~once~~.

In accordance with the invention, the following effects are achieved.

It becomes possible to easily set up a plurality of illuminants on a concave face of a hollow truncated cone-shaped board by the following steps. First, ~~hold the~~ <sup>a</sup> flexible circular printed circuit board having a

5 concentric circular hole and a cutout which has at least two sides <sup>is held</sup> in a planar state. Next, <sup>are embedded</sup> embed a plurality of illuminants <sup>are printed together</sup> in the board. Finally, <sup>are held together</sup> joint one side of the cutout and the other side of the cutout <sup>of the cutout</sup> or hold both sides in close contact so as to place the illuminants in the ~~a~~

10 side of the concave face. As a result of this, ~~it is not necessary to provide~~ <sup>is not used</sup> a complicated process <sup>form</sup> to the underside of the lighting unit, ~~which makes it easy to assemble~~ <sup>is made easier and</sup> the lighting unit, ~~thereby to shorten~~ <sup>the lighting unit is shortened</sup> the time required to assemble. In addition, ~~since emitting angle~~ <sup>the</sup> angle <sup>emittance of the lighting unit</sup>

15 can easily be changed just by changing <sup>the</sup> diameter of <sup>the</sup> the board or <sup>the</sup> size of <sup>the</sup> cutout. <sup>As a result,</sup> it is easy to manufacture a variety of lighting units <sup>each a different</sup> with various angle of ~~emitting~~ <sup>emittance</sup> ~~light~~ <sup>that</sup> so <sup>can be fit</sup> as to fit to light a product to be examined.

If a printed circuit board is used as <sup>the</sup> a board, <sup>the</sup> wiring

20 operation is completed just by embedding the illuminants in the board. <sup>this simplifies the</sup> Then <sup>step</sup> a process of assembling the lighting unit ~~is simplified~~ because a complicated process <sup>step</sup> such as wiring each of the illuminants, can be omitted.

#### BRIEF DESCRIPTION OF THE DRAWINGS

25 The objects and features of the invention may be understood with reference to the following detailed description of illustrative embodiments of the invention, taken together with the accompanying drawings in which;

Fig. 1 is a cross sectional end view of a lighting unit showing a preferred embodiment of this invention,

Fig. 2 is a front view showing the board on which illuminants are mounted prior to assembling of the lighting unit shown in Fig. 1,

Fig. 3 is a cross sectional end view of a lighting unit showing a modification of the preferred embodiment, and

Fig. 4 is a front view showing the board on which illuminants are mounted prior to assembling of the lighting unit shown in Fig. 3.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the invention will now be described below with reference to Fig. 1 and Fig. 2.

As shown in Fig. 1, a plurality of illuminants 1 such as light-emitting diodes are arranged on <sup>an</sup>underside of a lighting unit 4, namely on a concave face 2c of a hollow truncated cone-shaped flexible printed circuit board 2, and a lighting case 3 holds the illuminants 1 together with the board 2. Power is supplied to each of the illuminants 1 from a power cable 5, <sup>extending</sup> through the board 2. The lighting case 3 is provided with a center hole 32 for visual inspection or taking photos <sup>of the surface to be inspected.</sup> and a frame 33 <sup>is used to</sup> retaining the illuminants 1 and the board 2. An internal thread 31 formed in the lighting case 3 is for mounting the lighting unit 4.

With the above-mentioned arrangement, a method of manufacturing a lighting unit in accordance with the

invention will now be explained. First, hold <sup>the</sup> a flexible printed circuit board 2, <sup>is held</sup> in a planar state. The shape of the board 2 is a circle with a concentric, <sup>circular</sup> circle hole and a cutout having two sides 2a, 2b. Next, <sup>are embedded</sup> embed the illuminants 1, in the board 2 by means of soldering or the like. Then, <sup>are joined together</sup> joint one side 2a of the cutout and the other side 2b of the cutout, <sup>of the cutout are kept</sup> or keep both sides 2a, 2b in close contact so as to place the illuminants 1 in the side of <sup>the</sup> concave face 2c. Then, <sup>As a result, the</sup> the board 2 is inevitably transformed into a shape of a hollow truncated cone and the illuminants 1 are set up on the concave face 2c of the hollow truncated cone-shaped board 2. <sup>as shown in Figs. 1 and 3.</sup> At the same time, <sup>is wired into</sup> wire a power cable 5 in the board 2 by means of soldering or the like. Finally, <sup>the</sup> mount the formed board 2 and illuminants 1, <sup>are mounted</sup> to the lighting case 3 through the frame 33, thereby to manufacture the lighting unit 4.

In accordance with the above-mentioned method of manufacturing the lighting unit 4, it is possible to embed the illuminants 1 in the board 2 when the board 2 is in a planar state. Therefore, in this case the same method <sup>used to mount electrical parts on an original printed circuit board</sup> can be applied ~~as the method by which electrical parts are~~ mounted on an ~~original printed circuit board~~. In addition to that, since the printed circuit board 2 is used as <sup>the</sup> a board, <sup>the step of individually wiring each illuminant 1</sup> wiring operation can be omitted, <sup>can be embedded</sup> just by embedding the illuminants 1, in the board 2 by means of soldering or the like, <sup>is simplified</sup> thereby to simplify a process of assembling the lighting unit 4. When one side 2a of the cutout and the other side 2b of the cutout are jointed or both sides 2a,

*of the cutout*  
2b are kept in close contact so as to place the  
illuminants 1 in the side of a concave face, the board 2  
is bent and inevitably transformed into *the* shape of a  
hollow truncated cone, *this shape* which makes it easy to arrange the  
5 illuminants 1 on the concave face 2c of the hollow  
truncated cone-shaped board 2. Thus, formed board 2 and  
illuminants 1 are easily mounted to the underside of the  
lighting case 3 through the frame 33. Also, there is no  
need *for* of processing the lighting case 3 into a shape of *a*  
10 concave *portion* of a conic or a truncated cone nor *a* need *for*  
of perforating holes *in the printed circuit board* to embed *the* illuminants. As shown in Figs.  
3 and 4, a hollow truncated cone shape having an arbitrary  
size and angle can easily be formed just by changing a  
diameter of the board 2 or a size of *the* cutout. In  
15 addition, *the light* emitting angle can easily be changed just by  
changing the frame 33 tailored to fit the truncated cone  
shape, namely by changing only a part of the lighting  
unit.

This invention is not limited to the embodiments  
20 described in detail hereinabove. For example, the board 2  
may be a shape of *an* ellipsoid having a cutout to vary a  
shape of *light emitting* a surface ~~emitting light~~.

Moreover, each of the arrangements is not limited to  
that illustrated in the figures and there may be various  
25 modifications without departing from the spirit and  
essential characteristics thereof.



# ABSTRACT OF THE DISCLOSURE

~~An object of the invention is to make it easy to~~  
~~manufacture the~~ <sup>A method of manufacturing a</sup> lighting unit ~~in~~ <sup>in</sup> which a plurality of  
illuminants ~~are~~ <sup>are</sup> arranged on the concave face of a board  
5 ~~formed into~~ <sup>the</sup> shape of a hollow truncated cone. ~~The method includes~~  
~~the method of manufacturing a lighting unit comprises~~  
→ the steps of holding a flexible circular printed circuit  
board ~~having~~ <sup>with</sup> a concentric circular hole and a cutout  
which ~~has~~ <sup>at</sup> least two sides ~~2a, 2b~~ in a planar state,  
10 embedding a plurality of illuminants ~~in~~ <sup>in</sup> the board, and  
jointing one side ~~2a~~ of the cutout and the other side ~~2b~~  
of the cutout or holding both sides ~~2a, 2b~~ <sup>of the cutout</sup> in close  
contact so as to place the illuminants ~~in~~ <sup>in</sup> the ~~side~~ <sup>a</sup> of  
the concave face of the board ~~.~~

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